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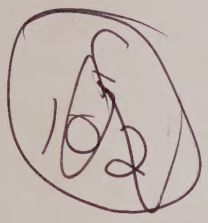

Quan-Tech®

Div. of Scientific-Atlanta, Inc.

Specialists in Electronic Instrumentation

Randolph Park West, Randolph Township, New Jersey 07801
Telephone: (201) 361-3100 TWX 710-987-7946

VIKING LABORATORIES INC.

INSTRUCTION MANUAL

MODEL 512 B

TRANSISTOR NOISE TEST SET

FOR SERIAL NO. _____

Q U A N - T E C H

DIV. OF SCIENTIFIC-ATLANTA, INC.

RANDOLPH PARK WEST, ROUTE 10 RANDOLPH TOWNSHIP, N.J. 07801

201-361-3100

Addendum to Model 512 Manual for Model 512 B

The Model 512B retains all of the operating features and specifications of the Model 512 and in addition provides a low frequency Noise Figure measurement over the frequency range of 10 Hz to 50 Hz.

In the LF position of the front panel toggle switch a 50 Hz low-pass filter/ amplifier is switched into the circuit between Amplifier #4 (Ass'y 4611) and the Meter Amplifier (Ass'y 4612). The 50 Hz filter/ amplifier assembly provides the upper 3db cutoff frequency of 50 Hz and the additional voltage gain of 14 which is required when making the narrow band measurement.

Noise calibration is accomplished on the narrow band filter/ amplifier by calibrating in "BB" in the standard way as described in Section 5 of the manual, then switching to the LF position of the front panel switch and adjusting the 10-50 Hz CAL potentiometer for the same Noise Figure reading in LF as was obtained in BB. (For this adjustment, calibration must be checked with a white noise source.)

INSTRUCTION MANUAL

MODEL 512

TRANSISTOR NOISE TEST SET

for Serial No.

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PHONE (201) 361-3100 TWX 710-987-7946

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CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Quan-Tech, division of Scientific-Atlanta, Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electronic tubes and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepared by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misadjustments, misuse, or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

Calibration checks of this instrument can easily be made in accordance with the instruction manual. Routine readjustments **should never** be attempted. If, however, the instrument has been damaged and requires recalibration or alignment, explicit calibration procedures as defined in the instruction manual **must** be followed.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory. If requested an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

The instruments should be packed in their original containers, or in a strong exterior container and surrounded by two inches of shock absorbing material.

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RANDOLPH PARK WEST, ROUTE 10, RANDOLPH TOWNSHIP, NEW JERSEY 07801
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SECTION 1
GENERAL

A. DESCRIPTION

The Model 512 Transistor Noise Test Set is a compact, simplified unit designed to measure the noise figure of transistors over the frequency range of 10 cycles to 10 kilocycles. Voltage sensitive devices may be measured as well as conventional junction transistors, within the transconductance range of from 400 to 40,000 micromhos. The front panel meter readout is noise figure in db and is automatically calibrated for the internally available base resistances of 50, 500, 1000 and 10,000 ohms. A position of the BASE RESISTANCE switch and terminals on the test jig are provided for the insertion of base resistances other than the above. In the EXT. position of the BASE RESISTANCE switch the front panel noise meter will read noise voltage in db with one nanovolt per root cycle of white noise used as the zero db reference. Direct readout in db, automatic calibration and ease of operation make the Model 512 ideally suited to production and quality control applications.

B. SPECIFICATIONS

NOISE:

Noise figure measured directly in db for selected base resistances of 50, 500, 1000 and 10,000 ohms.

Noise voltage measured in db with one nanovolt per root cycle of white noise used as the zero db reference in the EXT. position of the BASE RESISTANCE switch.

All measurements made with an equivalent noise bandwidth of 15.7 Kc. The upper and lower 3 db frequencies are 10 kilocycles and 10 cycles respectively.

Meter Readout: Zero to 12 db with meter multiplier switch extending range to 62 db in 10 db steps.

Accuracy: ± 1 db.

COLLECTOR VOLTAGE:

± 3 to 30 volts.

Meter Ranges: 10 and 30 volts full scale.

Meter Accuracy: ± 5% of full scale.

B. SPECIFICATIONS (Cont'd)

COLLECTOR CURRENT:	Range: 10 to 1000 microamperes.
	Meter Ranges: 30, 100, 300 and 1000 microamperes full scale.
	Meter Accuracy: ± 5% of full scale.
ANALOG OUTPUT:	0 to + 1 volt, proportional to noise meter reading.
DIMENSIONS:	12"Wx 6"Hx8"D, weight 12 lbs.
POWER INPUT:	117/234 volts, 50-60 cycles, 6 watts.

SECTION 2
OPERATION

A. FIRST TIME OPERATION

1. Connect the line plug of the instrument to a suitable source of power. (Check the voltage plate at the rear of the chassis for primary voltage). If the internal primary power connections must be changed, refer to SECTION 5 for instructions.

2. Turn the power switch to ON. Set the front panel voltage and current controls for the transistor type, collector voltage and collector current desired. Note that the meters for current and voltage always read the operating conditions which will exist if a functioning transistor is placed in the test jig and the jig interlock closed.

3. Insert the transistor to be tested in the test socket and close the jig cover.

4. Set the METER MULTIPLIER switch for an on-scale reading of the NOISE FIGURE meter. The NOISE FIGURE meter will now be indicating the noise figure of the transistor under test for the preset operating conditions and the base resistance indicated by the position of the BASE RESISTANCE switch.

   Note that in the EXT. position of the BASE RESISTANCE switch the front panel meter reads total noise in DB rather than NOISE FIGURE directly. In order to obtain noise figure when the BASE RESISTANCE switch is in the EXT. position, the thermal noise (in DB) of the base resistance must be subtracted from the total noise reading. Thermal noise in DB for a particular base resistance value is obtained by finding the thermal noise voltage on the chart given in Figure 2-2, then converting this to DB by using the chart given in Figure 2-1.

B. FRONT PANEL METERS AND CONTROLS

1. Noise Meter and Meter Multiplier

   The NOISE FIGURE meter is automatically calibrated to read noise figure directly for all positions of the BASE RESISTANCE switch except EXT. The correct noise figure reading is always the sum of the METER MULTIPLIER position and the NOISE FIGURE meter indication.

   In the EXT. position of the BASE RESISTANCE switch the panel meter is calibrated to read noise voltage referred to the base of the transistor under test using one nanovolt per root cycle of white noise as the zero db reference. As in the noise figure measurements the correct noise reading is always the sum of the METER MULTIPLIER and the panel meter indication.

B. FRONT PANEL METERS AND CONTROLS (Cont'd)

2. Ammeter, Current Range Switch and Current Adjust.

The front panel metering for collector current is an indicator of the current which will exist if a functioning transistor is placed in the test jig and the shield cover closed. Note that the panel meter is not actually monitoring the collector current and does indicate with a transistor in or out of the test socket and with the shield cover open or closed.

The complete current range of the instrument is obtainable through the use of the range switch and the smaller concentric control which gives a variation of from one third scale to full scale.

3. Voltmeter, Voltmeter Multiplier and Voltage Adjust.

The voltmeter range switch serves to select the polarity of the collector voltage (NPN-PNP) in addition to the full scale sensitivity of the panel meter. The smaller concentric control provides continuous adjustment of the collector voltage over the full range of from 3 to 30 volts.

NOTE:

For transistors having very low current gain or for operation at high values of collector current with high values of base resistance, the collector voltage may have to be set greater than three volts. A problem in this area usually shows up as erratic behavior of the NOISE meter. (Abnormally high or abnormally low reading).

4. Test Jig.

Two sockets for the transistor to be tested, a voltage interlock switch activated by the shield cover, binding posts for an external base resistor and a base resistance selector switch are located on the test jig. The very low measuring levels of this equipment require that the test sockets, test transistor and base resistors be shielded when a noise measurement is being made. The hinged cover accomplishes the required shielding and also activates the interlock switch which removes the base voltage for loading and unloading. This cover should therefore be closed when a noise measurement is being made.

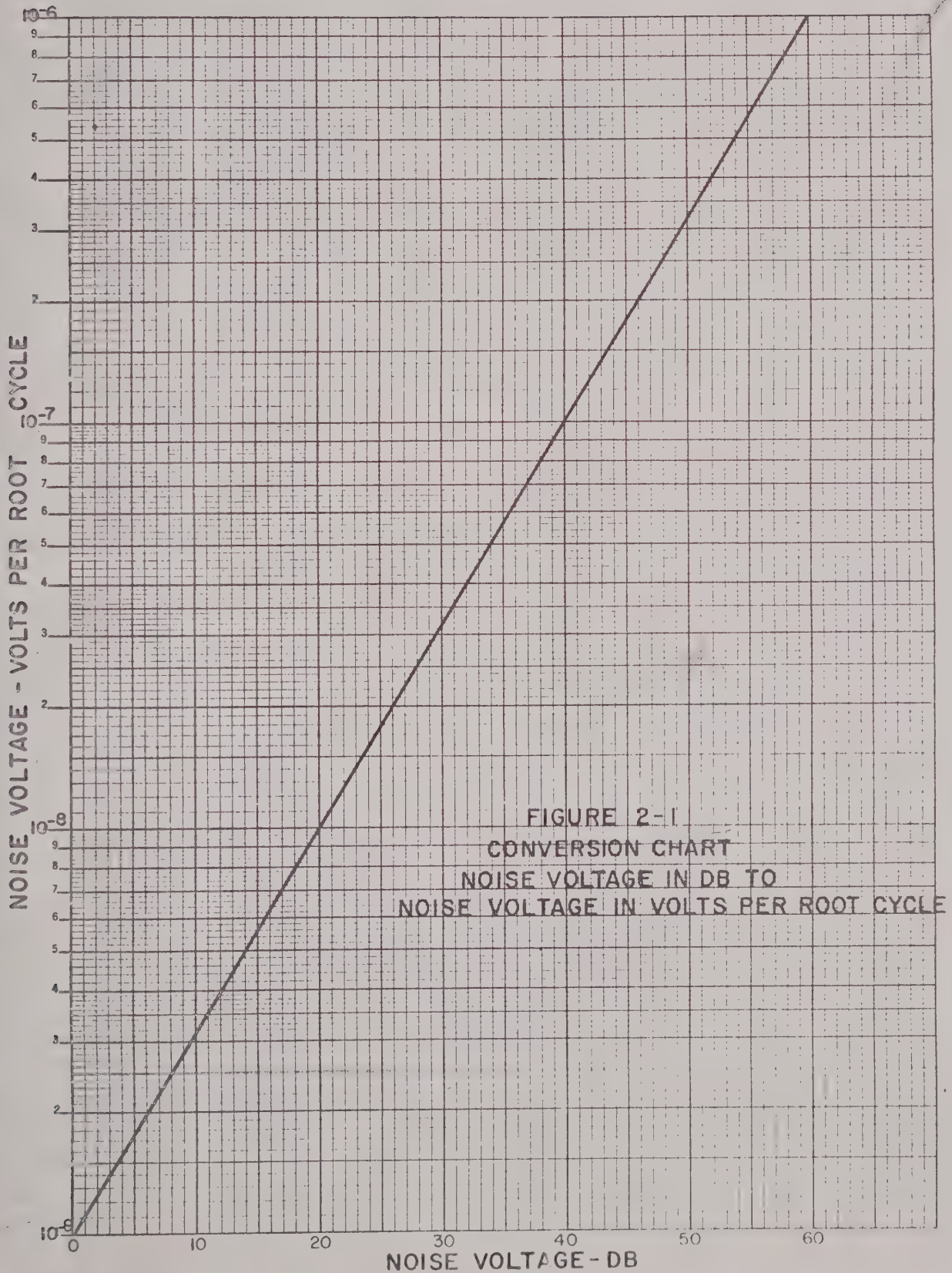

FIGURE 2-1
CONVERSION CHART
NOISE VOLTAGE IN DB TO
NOISE VOLTAGE IN VOLTS PER ROOT CYCLE

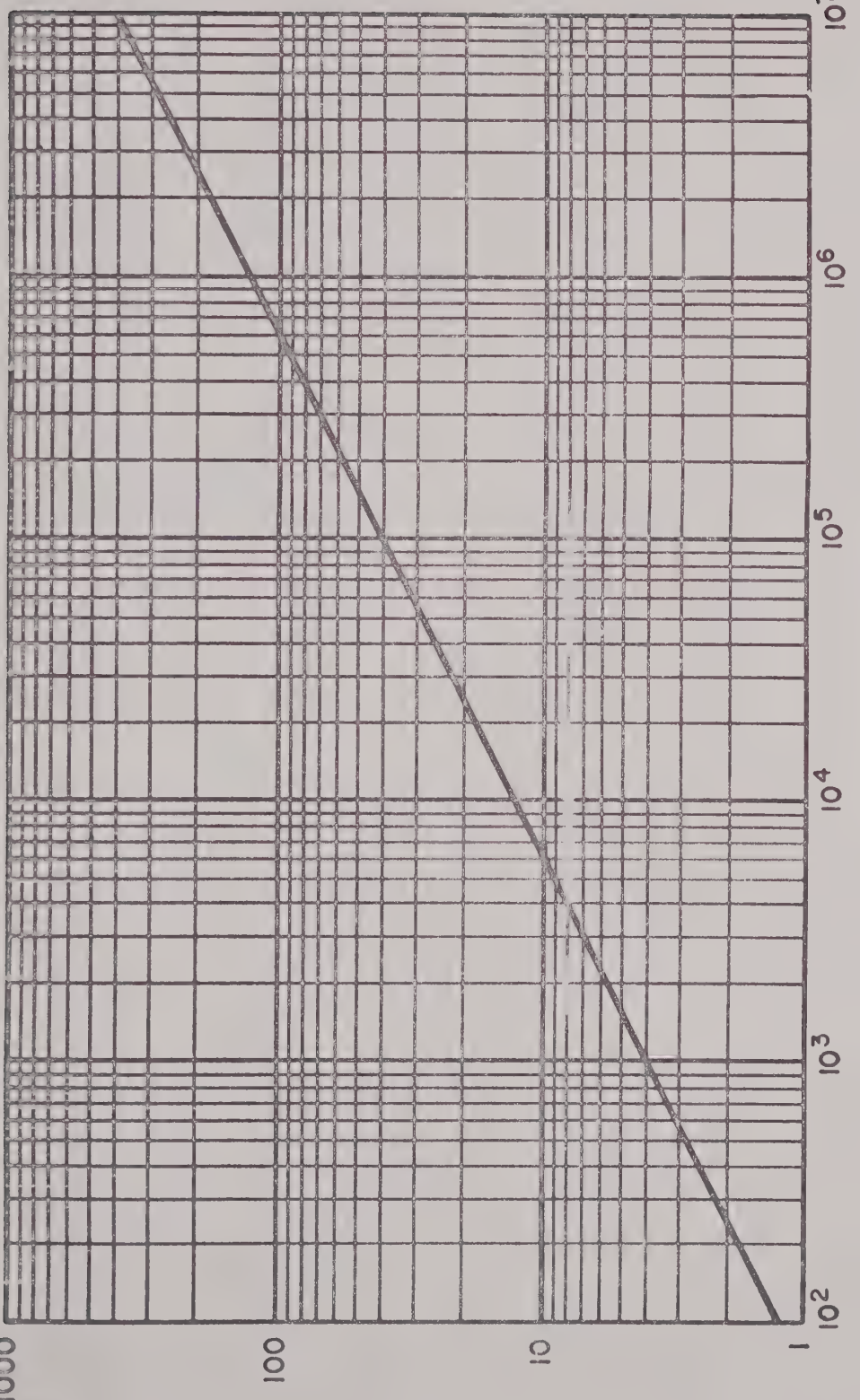

FIGURE 2-2
THERMAL NOISE VOLTAGE vs RESISTANCE

SECTION 3

THEORY OF OPERATION

A. GENERAL

The basic method of calibration of this equipment is the known gain; known bandwidth method. Gain calibration is obtained by including the transistor under test in a feedback amplifier. (See Block Diagram). The transistor under test, the Pre-amplifier and Amplifier #2 are connected such that their gains multiply to drive a resistive feedback divider. The result is a constant voltage gain from the base of the transistor under test to the output of Amplifier #2.

The remainder of the noise channel is straightforward amplification and attenuation. One section of the attenuator is connected to the BASE RESISTANCE switch so that the overall gain is changed as required for each of the values of base resistance.

The bandpass filter has 6 db per octave skirts, 10 cycle and 10 kilocycle 3 db down points and a corresponding 15.7Kc equivalent noise bandwidth.

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Whippany, N. J.
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June 15, 1966

A DISCUSSION OF ERRORS DUE TO BANDWIDTH WHEN MAKING SPOT NOISE MEASUREMENTS

Considerable confusion occasionally arises over the effect that bandwidth has on the accuracy of spot noise measurements which, by definition, refer to an equivalent noise bandwidth of one Hz. Practically all noise analyzers use an equivalent noise bandwidth much greater than one Hz and effectively divide the actual noise voltage by the square root of the bandwidth to obtain spot noise or noise spectral density. If the noise being measured is white (amplitude constant with frequency) there is no problem in accepting the above philosophy, however, most semiconductors generate considerable amounts of 1/f noise which has an amplitude characteristic inversely proportional to the square root of the frequency. The question arises as to how much error is introduced in a given bandwidth if 1/f noise is present. Some transistor specifications have even gone so far as to specify the bandwidth (200 Hz for 1 KHz spot noise figure) in an attempt to minimize the error. The following analysis has been made to show that bandwidth, within reason, contributes basically no error regardless of whether white or 1/f noise is present.

Spot noise measurements (equivalent noise bandwidth of one Hz.) taken on a Quan-Tech Laboratories Model 310 are actually made with filter bandwidths of typically 300 Hz and 900 Hz for the 1 KHz and 10 KHz channels respectively. The error in the noise measurement introduced by measuring over these particular bandwidths instead of one Hz bandwidth is as follows:

Conversion factors for white noise:

$$E_{\text{total in 300 Hz BW}} = E_{1\text{KHz}} \ (300)^{1/2} = E_{1\text{KHz}} \ (17.32)$$

$$E_{\text{total in 900 Hz BW}} = E_{10\text{KHz}} \ (900)^{1/2} = E_{10\text{KHz}} \ (30)$$

Conversion factors for 1/f noise

$$E_{\text{total in 300 Hz BW}} = E_{1\text{KHz}} \ (1\text{KHz})^{1/2} \ \left(\ln \frac{f_2}{f_1}\right)^{1/2}$$

$$= E_{1\text{KHz}} \ (31.6) \ \left(2.3 \log \frac{1160}{860}\right)^{1/2}$$

$$= E_{1\text{KHz}} \ (17.30)$$

$$E_{\text{total in 900 Hz BW}} = E_{10\text{KHz}} \ (10\text{KHz})^{1/2} \ \left(\ln \frac{f_2}{f_1}\right)^{1/2}$$

$$= E_{10\text{KHz}} \ (10^2) \ \left(2.3 \log \frac{10460}{9560}\right)^{1/2}$$

$$= E_{10\text{KHz}} \ (29.9)$$

It can be seen from the above that the error resulting from using the white noise conversion factor when the noise is actually 1/f is essentially zero. Even bandwidths as wide as 1KHz geometrically centered around 1 KHz contribute negligible error compared to the other errors usually associated with the measurement of random noise.

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1 KHz SPOT NOISE FIGURE vs BROADBAND NOISE FIGURE [1]

The following is an analysis of the difference to be expected between noise figure measurements made by these two presently accepted standards.

The 1 KHz spot noise figure is measured at 1 KHz with the bandwidth of the detector small as compared to 1 KHz. Both the thermal noise of the source and the white, as well as 1/f noise contributed by the device under test are measured at 1 KHz only.

In the broadband case, the noise figure is measured over a bandwidth extending from 10 Hz to 10,000 Hz. This bandpass is specified to be 3db down at 10 and 10,000 Hz, and to have a 6db/oct roll-off. The broadband noise figure is a measure of the white and 1/f noise generated within this bandpass, including the skirts.

Table No. 1 lists the noise figure for both the broadband and 1 KHz spot methods, assuming all white noise to be generated by the source resistance, and all noise generated by the device, to be 1/f. This results in the maximum deviation between the two methods. If the device under test contributes white noise (thermal and shot) as well as 1/f noise, the difference will be less.

TABLE NO. 1

1 Kilz spot noise figure in db	Broadband noise figure in db	ΔN.F. in db
0.5	0.20	0.30
1.0	0.42	0.58
2.0	1.00	1.00
3.0	1.58	1.42
5.0	2.90	2.10
7.0	4.40	2.60
10.0	6.95	3.05
20.0	16.42	3.58

The noise voltage contained within a bandpass may be expressed as:

$$\overline{E^2}^{1/2} = \left[\int_0^\infty E^2(F)\,G^2(F)\,df\right]^{1/2} \qquad \text{EQUATION 1}$$

or the voltage squared:

$$\overline{E^2} = \int_0^\infty E^2(F)\,G^2(F)\,df \qquad \text{EQUATION 2}$$

where $E^2(F)$ describes the noisepower spectrum and $G^2(F)$ describes the power gain of the circuit.

Since the broadband measurement contains a low pass and a high pass filter, the gain function is:

$$G_{LP}(F) = \frac{1}{\left(1 + \frac{f^2}{f_2^2}\right)^{1/2}} \qquad \text{EQUATION 3}$$

$$G^2_{LP}(F) = \frac{f_2^2}{f_2^2 + f^2} \qquad \text{EQUATION 4}$$

$$G_{HP}(F) = \frac{1}{\left(1 + \frac{f_1^2}{f^2}\right)^{1/2}}$$ EQUATION 5

$$G^2_{HP'}(F) = \frac{f^2}{f_1^2 + f^2}$$ EQUATION 6

where f_2 and f_1 are the upper and lower cutoff frequencies.

Thus the magnitude of the white noise contained in the broadband measurement where $E^2(f)$ is a constant for all frequencies and is assigned unit magnitude is given by:

$$\overline{E_W^2} = \int_0^\infty G^2_{LP}(F)\, G^2_{HP}(F)\, df$$ EQUATION 7

$$\overline{E_W^2} = \int_0^\infty \left(\frac{f^2}{f_1^2 + f^2}\right)\left(\frac{f_2^2}{f_2^2 + f^2}\right) df$$ EQUATION 8

By partial fraction expansion we have:

$$\overline{E_W^2} = \int_0^\infty \left[\frac{\frac{1}{(f_2^2 - f_1^2)}}{f_1^2 + f^2} + \frac{\frac{1}{(f_1^2 - f_2^2)}}{f_2^2 + f^2}\right] f_2^2\, f^2\, df$$ EQUATION 9

$$\overline{E_W^2} = \frac{f_2^2}{f_2^2 - f_1^2}\left(f - f_1 \tan^{-1}\frac{f}{f_1}\right) + \frac{f_2^2}{f_1^2 - f_2^2}\left(f - f_2 \tan^{-1}\frac{f}{f_2}\right)\Bigg|_0^\infty$$ EQUATION 10

$$\overline{E_W^2} = \frac{f_2^2}{f_2^2 - f_1^2}(f_2 - f_1)\frac{\pi}{2} = \frac{f_2^2}{f_2 + f_1}\frac{\pi}{2}$$ EQUATION 11

f_1 = 10 Hz and f_2 = 10,000 Hz

Therefore:

$$\overline{E_W^2} = 15.7 \times 10^3 \text{ VOLTS}^2$$ EQUATION 12

The derivation of the magnitude of 1/f noise is similar to the above for white noise. Prior to integration, equation 9 should be multiplied by 1/f, since in this case the function $E^2(F) = 1/f$.

$$\overline{E^2_{1/f}} = \int_0^\infty \left[\frac{\frac{1}{(f_2^2 - f_1^2)}}{f_1^2 + f^2} + \frac{\frac{1}{(f_1^2 - f_2^2)}}{f_2^2 + f^2}\right] f_2^2\, f\, df$$ EQUATION 13

$$\overline{E^2_{1/f}} = \frac{1}{2} \frac{f_2^2}{f_2^2 - f_1^2} \left(\ln f^2 + f_1^2 - \ln f^2 + f_2^2 \right) \Big|_0^\infty$$

EQUATION 14

$$\overline{E^2_{1/f}} = \frac{1}{2} \frac{f_2^2}{f_2^2 - f_1^2} \ln \frac{f^2 + f_1^2}{f^2 + f_2^2} \Big|_0^\infty$$

EQUATION 15

$$\overline{E^2_{1/f}} = \frac{f_2^2}{f_2^2 - f_1^2} \ln \frac{f_2}{f_1}$$

EQUATION 16

Again f = 10 Hz and f_2 = 10,000 Hz and

$$\overline{E^2_{1/f}} = 6.9 \text{ VOLTS}^2 \text{ (unit spectral density at 1Hz)}$$

EQUATION 17

The above solution is based on unit spectral density for the 1/f noise at 1 Hz. For comparison the 1/f noise should be set equal to the white noise at 1 KHz. Thus a multiplier of 1000 is required and:

$$\overline{E^2_{1/f}} = 6.9 \times 10^3 \text{ VOLTS}^2 \text{ (unit spectral density at 1KHz)}$$

EQUATION 18

$$\frac{\overline{E^2_{1/f}}}{E^2_W} = \frac{6.9 \times 10^3}{15.7 \times 10^3} = .44 \text{ or } -3.58 \text{ db}$$

EQUATION 19

Table No. 1 is derived from equations 20 and 21.

$$\text{1KHz SPOT N.F.} = \frac{4kTRg + E^2_{1/f}}{4kTRg}$$

EQUATION 20

$$\text{BROADBAND N.F.} = \frac{4kTRg(15.7 \times 10^3) + E^2_{1/f}(6.9 \times 10^3)}{4kTRg(15.7 \times 10^3)}$$

EQUATION 21

where Rg - generator or source resistance and $E^2_{1/f}$ = 1/f noise spectral density at 1 KHz.

(1) Prepared by Quan-Tech Laboratories, Inc. 43 South Jefferson Road, Whippany, N. J.

A. GENERAL

The Block Diagram, T-4630, shows the basic connections between individual circuits. Reference to the diagram and the appropriate schematic diagram will enable the reader to follow the individual circuit descriptions.

B. PRIMARY POWER AND BIAS SUPPLIES (Schematic T-4636)

The line connections, power switch and fuse are shown on this schematic. The multiple secondaries are labelled in accordance with their circuit association.

The +12 volt supply is a straightforward double differential, regulated power supply which is the main dc power source for the entire test set. In this supply the voltage difference between the zener diode, CR103 and the voltage at the junction point of R103 and R104 is detected and amplified by the double differential configuration of Q101, Q102, Q103 and Q104 and applied to the series regulator transistor Q105. The resulting action of Q105 serves to maintain a constant voltage at the output terminals of the supply independent of load.

The -6 volt supply is a light load, zener regulated supply which receives its unregulated dc from the collector of Q105 of the +12 volt supply.

C. COLLECTOR CURRENT SUPPLY (Schematic T-4632)

The collector current supply is a regulated supply whose output voltage can be varied from 10 volts to 30 volts using the front panel current adjust control. The reference voltage for this supply is obtained through the use of a double zener circuit involving CR207, Q201 and CR208. Fixed resistor, R205, across the reference voltage generates a constant current through the voltage control R213. Q202 and Q203 serve as a two stage error amplifier which monitors the output voltage and drives the series regulator Q205 to maintain the desired regulated output voltage.

D. COLLECTOR VOLTAGE SUPPLY (Schematic T-4633)

The operation of this supply is the same as that of the CURRENT supply and should require no further explanation.

E. PREAMPLIFIER (Schematic C-4634)

The preamplifier provides the dc bias control for the transistor under test in addition to the obvious function of noise amplification. The four detector transistors Q401, Q402, Q403 and Q404 function two at a time; Q401 and Q404 apply in the NPN test

CIRCUIT DESCRIPTION (Cont'd)

E. PREAMPLIFIER (Schematic C-4634) Cont'd

position and Q402 and Q403 function for the PNP position. The voltage between pins 9 and 10 is the control voltage that determines the collector current in the test transistor. For the NPN test (shown in the schematic) Q401, Q404 and Q405 are the functioning transistors which control the dc operating condition of the transistor under test.

The current gain of Q404 (or Q403 for PNP) is realized for noise amplification, the noise output of the preamplifier being taken across R416.

F. AMPL. #2, ATTN, AMPL. #3 AND FILTER (Schematic T-4635)

Amplifier #2 is a straightforward two stage amplifier utilizing negative feedback for gain stabilization, and an emitter follower for the noise output.

The output of Ampl. #2 is applied to the emitter of the transistor under test through R428. Application of negative feedback around the test transistor in this way provides a constant gain closed loop which is independent of the test transistor parameters.

The noise signal is also applied to the input of Amplifier #3 through emitter follower, Q507, the BASE RESISTANCE switch attenuator, R512 through R515, and the METER MULTIPLIER, R516 through R522.

Ampl. #3 is very much like Ampl. #2 except that it has the additional power gain stages Q505 and Q506 which are required to drive the bandpass filter, B-4614. Negative feedback is employed in Ampl. #3 also for gain stabilization.

The bandpass filter, B-4614, has an equivalent noise bandwidth of 15.7 Kc. This bandwidth is achieved through the use of 6 db per octave skirts and 3 db points of 10 cycles and 1[illegible] kilocycles.

G. AMPL. #4, METER AMPL. AND LOG CONVERTER (Schematic T-4636)

Ampl. #4 is identical in operation to Ampl. #3. The gain of this amplifier is adjusted with R606 to achieve overall gain calibration at zero DB meter indication. (Procedure is given in Section 5.)

Q605 and Q606 are the two active stages of the meter amplifier. The emitter of Q606 appears as a constant current source due to the negative feedback configuration. Q607 provides the required dc bias to Q606 without appearing as a shunt load across the metering circuit of CR602, CR604, C608, R629, R630 and meter M601.

Diode CR605 allows the resistive divider associated with R632 to shunt the metering circuit on the upper half of the meter scale providing a more nearly linear spacing of the db calibration marks. R634 determines the amount of compression on the upper end of the meter scale and is therefore used for the 10 DB calibration.

A. GENERAL

The approach taken in the design of this equipment was to virtually eliminate preventive maintenance. All active and unidirectional components are solid state and have undergone a rigorous noise screening program to insure long life.

Precision value resistors have also been used in many areas to eliminate the need for periodic adjustment.

The only adjustments in this equipment are two noise calibration adjustments, one for each end of the NOISE FIGURE meter. It is recommended that the adjustments be changed only after it has been firmly established that it is required.

In the event that servicing is required and the instrument is removed from its case, the following precautions should be observed:

1. Turn main power off when connecting or disconnecting printed circuit assemblies to avoid transients.

2. Make voltage checks on the connector board using the voltage chart supplied, being careful not to short out adjacent copper in the process.

3. In soldering the printed circuit boards have the iron only hot enough to make a clean rapid joint and DO NOT apply any force which would tend to push the copper away from the board.

B. REMOVAL OF THE CASE

Remove the four No.8 binder head screws from the rear of the case and gently slide the unit forward out of the case. It will be necessary to raise the handle during this process.

C. CHANGING THE INPUT VOLTAGE

This instrument has been designed to operate from either a 117 volt or a 234 volt AC power source. The plate on the rear of the instrument near the power cord indicates the voltage at which the instrument should be operated. If the input voltage must be changed, the procedure given should be followed:

1. Remove the case.
2. Change the transformer primary connections by moving the jumpers on the 4 terminal barrier strip located on the bottom of the printed circuit module connector board. Connect the jumpers as indicated in Figure 5-1.
3. Reverse the plate on the rear of the instrument to indicate the new voltage connections.
4. Replace the instrument in the case.

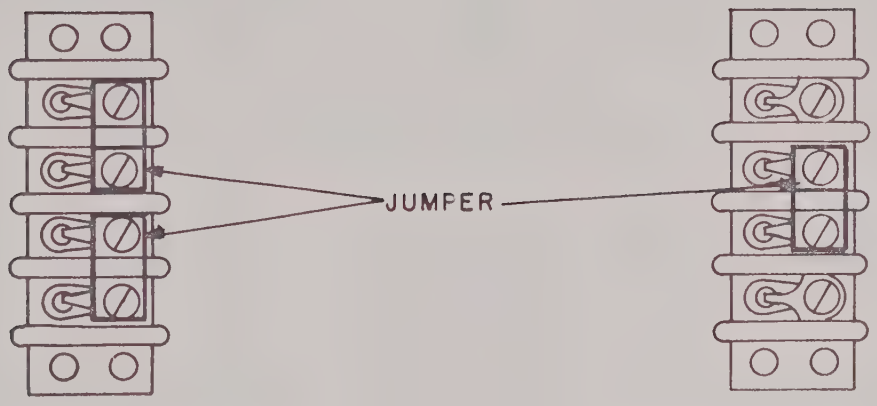


FIGURE 5-1. INPUT VOLTAGE BARRIER STRIP

D. DETAILED CALIBRATION

1. Positive 12 Volt Supply: This selection is normally made at the factory and should not require attention unless components have been changed on the circuit board.

    a. Select R105 for 12 volts dc between pins 8 and 9 of Ass'y 4625.

2. Input Noise Cal. Attenuator: Selection normally made at the factory and should not require attention again.

    a. Select R411 or R415 on Pre-Ampl. board to give 1000:1 attenuation from NOISE CAL jack, J401, to pin 7 of Pre-Ampl. board.

3. Noise Calibration:

    The NOISE meter calibration may be accomplished in either of two ways. The simplest of the two is to apply a known magnitude of white noise voltage to the input of the measuring system and adjust the overall gain for the correct noise voltage reading on the panel meter. The following procedure utilizes a Quan-Tech Laboratories Model 420 Random Noise Generator.

    a. Set the Model 512 current range switch to the full clockwise position; the BASE RESISTANCE switch to the EXT. position; place a short circuit across the EXT. terminals on the test jig; place a transistor in the test socket and close the jig shield cover. Check to see that the voltmeter range -NPN-PNP switch is in the proper position for the transistor in the test socket.

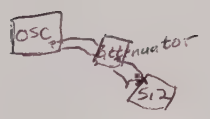
    b. Set the METER MULTIPLIER switch on the Model 512 to the +40 position and connect the output of the Model 420 to the NOISE CAL jack at the rear of the Model 512.

    c. Set the Model 420 METER MULTIPLIER switch to the X100 position; the termination switch to the UNTERM position and the VARIABLE output control for 1.0 meter indication.

    d. Adjust R606, 0 DB CAL, located on the module connector board between the connectors for Assemblies 4610 and 4611 for 0 DB indication on the NOISE FIGURE meter.

        NOTE: Due to the basic nature of measuring a random noise signal the NOISE meter reading will in general exhibit variations with time, dependent upon the actual filter bandwidth and the metering time constant. This condition must be understood and accepted if calibration with

D. DETAILED CALIBRATION (Cont'd)



3. Noise Calibration (Cont'd):

d. (Cont'd)

a noise source is to be accomplished. There is a certain amount of "integration by eye" required when using this technique, however, experience has shown that satisfactory calibration is quite easily obtained.

e. Set the METER MULTIPLIER switch on the Model 512 to the +30 position. Adjust R634, located just behind the VOLTAGE meter on the side plate, for 10 DB indication on the NOISE FIGURE meter.

The second method of calibration is the known gain, known bandwidth method. This method involves measurement of the filter bandwidth, the application of correction factors for the averaging meter circuit and conversion to equivalent noise bandwidth for the particular filter design. The following equation may be used to obtain the RMS sine wave calibrating voltage:

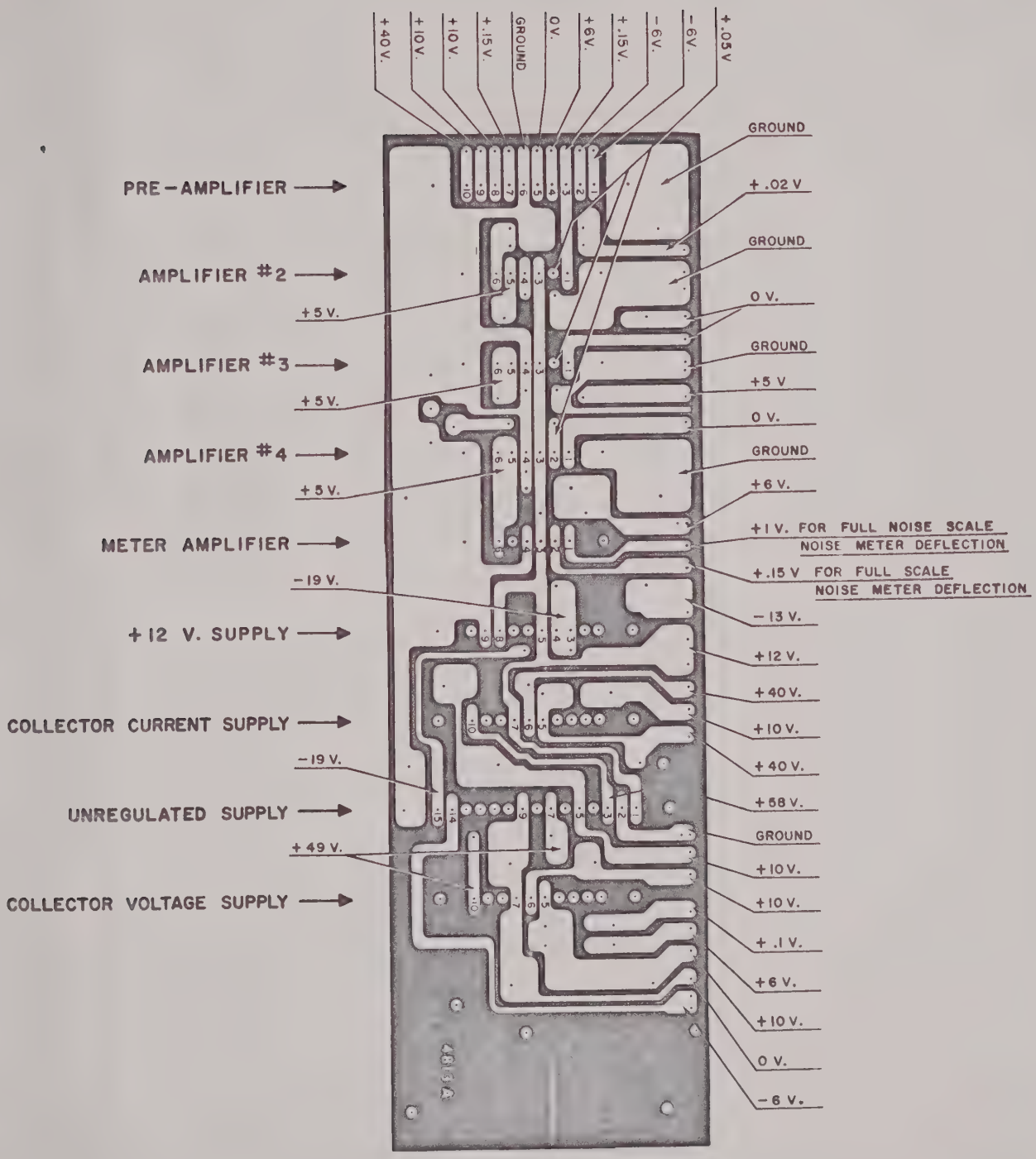
15.7 KC 10 - 10 KHz 15.7 KC

$$e_{cal} = (\text{NOISE BW})^{\frac{1}{2}} (\text{SCALE READING}) (888) \text{ volts}$$

where (NOISE BW) is the equivalent noise bandwidth of the filter, (SCALE READING) is the actual level or reading at which calibration is to be checked and (888) is the product of the correction factor for the average meter and the input attenuator ratio.

The equivalent noise bandwidth for the single section filter is 1.57 times the 3 db bandwidth.

The above procedure provides the method for obtaining a sine wave signal which is to be applied to the NOISE CAL jack the same as in the first calibration instructions. All other directions from the first method should be followed also.



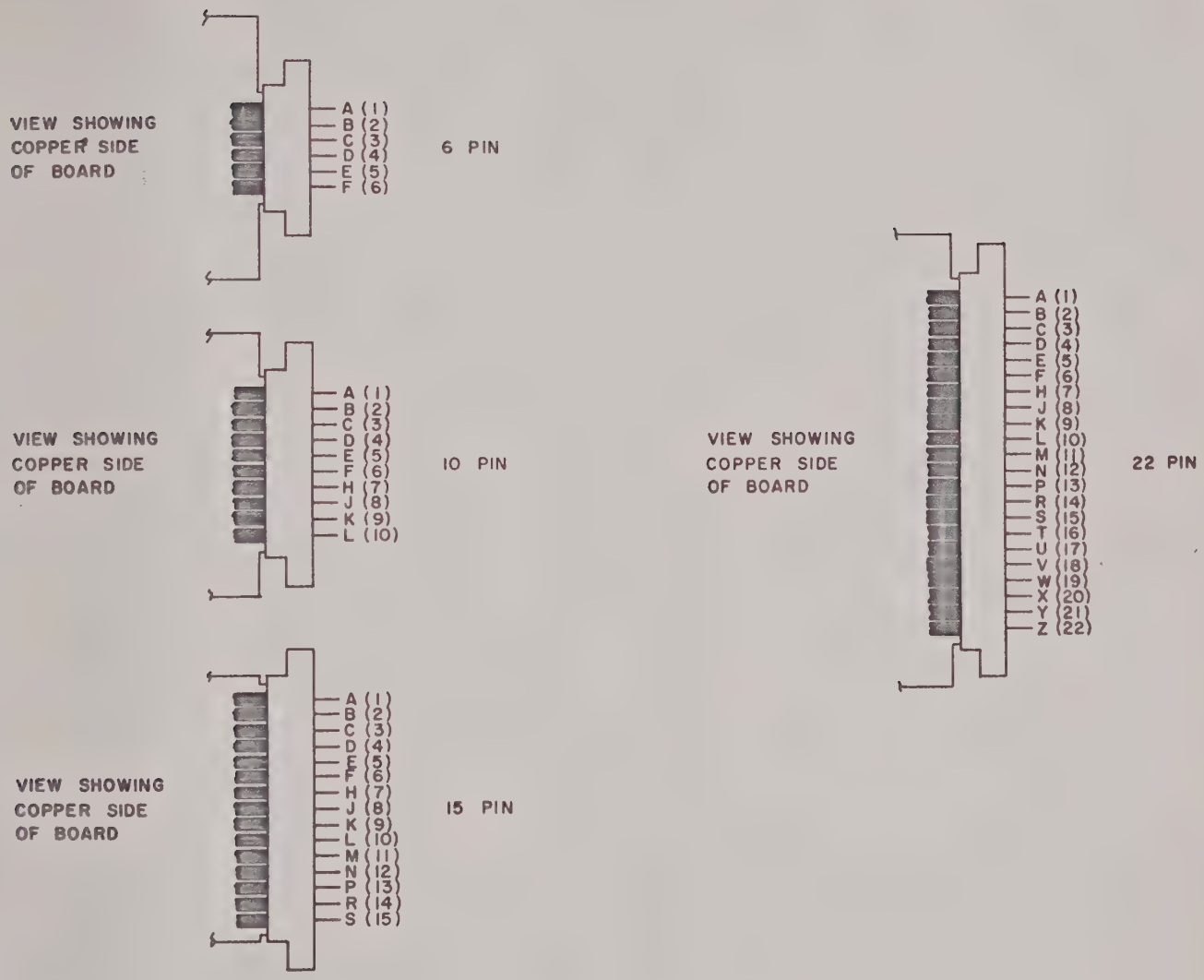
LINE VOLTAGE: 117 OR 234 VOLTS; GERMANIUM NPN TRANSISTOR IN TEST SOCKET AND COVER CLOSED; CURRENT RANGE-300 uA; CURRENT ADJUST-300 uA; VOLTAGE RANGE-10V, NPN; VOLTAGE ADJUST-10V; NOISE FULL SCALE - ON SCALE READING.

ALL VOLTAGES MEASURED TO GROUND WITH 20,000 OHM/VOLT D.C. VOLTMETER. A.C. VOLTAGES ARE GIVEN ON SCHEMATIC T-4631.

BOTTOM VIEW OF CONNECTOR BOARD

FIGURE 5-2

VOLTAGE CHART



PRINTED CIRCUIT BOARD CONNECTOR LUG IDENTIFICATION

SCHEMATIC LEGEND

k = 1000

⊘ = Screw Driver Adjustment

▭ = Front Panel Control

* = Factory Select

Unless Otherwise Specified:

All Resistances in Ohms

All Resistors 1/2 Watt

All Capacitances in Microfarads

SEMICONDUCTOR LEGEND

Changes and improvements in the semiconductor products available for commercial use necessitate type changes from time to time. To eliminate confusion and costly paperwork, many of these changes will be covered in the following legend. The purpose of this legend is to acknowledge the fact that the type number on a semiconductor found in a piece of equipment will not necessarily correspond with the type number given on the schematic diagram.

The legend is not intended to be an interchangeability list although in many cases good quality components* within a given category may be substituted with acceptable results. Normally, replacements should be made using components having the same type number as the component being replaced.

Those components bearing an asterisk on the schematic diagram are factory selected components and should be obtained from Quan-Tech.

*It should be noted that the incoming inspection procedure followed at Quan-Tech includes noise screening on most semiconductors.

TYPE NO. ON SCHEMATIC	TYPE NO. IN EQUIPMENT
1N482A	1N648, 1N3604, 1N3605
1N703	1N748, 1N749
1N709	1N753
1N2859	1N3253, 1N3254
1N2862	1N3254
1N3253	75A4, 1N3254
1N3254	75A4
1N3604	1N3605, 1N4151, 1N482A, 1N648
1N3605	1N3604, 1N4151, 1N482A, 1N648
MPD400	MPD401, 1N5179
TIS73	TIS74, TIS75, 2N4392
TIS74	TIS75, 2N4392
TIS75	TIS74, 2N4392
TI480	2N1613, 2N3566, 2N3643 A322, 2N929
TI494	2N1613, 2N3566, 2N3643, A322, 2N929
UC240	2N4869, 2N3819
2N270	2N3644, 2N3250, 2N3251
2N396A	2N414, 4JX1G759, 4JX1D653, 2N1305, 2N3644, 2N3250, 2N3251
2N414	2N396A, 4JX1G759, 4JX1D653, 2N1305, 2N3644, 2N3250, 2N3251
2N929	A322, A324, A642, 220N2, 2N930, 2N3566, 2N3643, 2N2219
2N1304	2N929, 2N930, 2N1306, 2N3566, 2N3643, A322
2N1306	2N929, 2N930, 2N1304, 2N3566, 2N3643, A322
2N1515	2N3644, 2N3250, 2N3251
2N1613	2N929, 2N930, 2N3566, 2N3643, A322, 2N2219
2N2219	D16C33, 220N2, A322, A324, A642, 2N929, 2N930, 2N3566, 2N3643
2N2603	2N3250, 2N3251, 2N3644
2N3250	2N3251, 2N3644
2N3251	2N3250, 2N3644
2N3566	2N3643, A322, 2N929, 2N2219
2N3643	2N3566, 2N2219, A322, 2N929
2N3644	2N3250, 2N3251, 2N3762
2N3762	2N3250, 2N3251, 2N3644
2N3819	TIS73, TIS74, TIS75, TIS58, TIS59, 2N4869, UC240
2N4392	TIS74, TIS75, 2N3819
2N4869	2N3819, UC240

SCHEMATIC LEGEND

k – 1000

– Screw Driver Adjustment

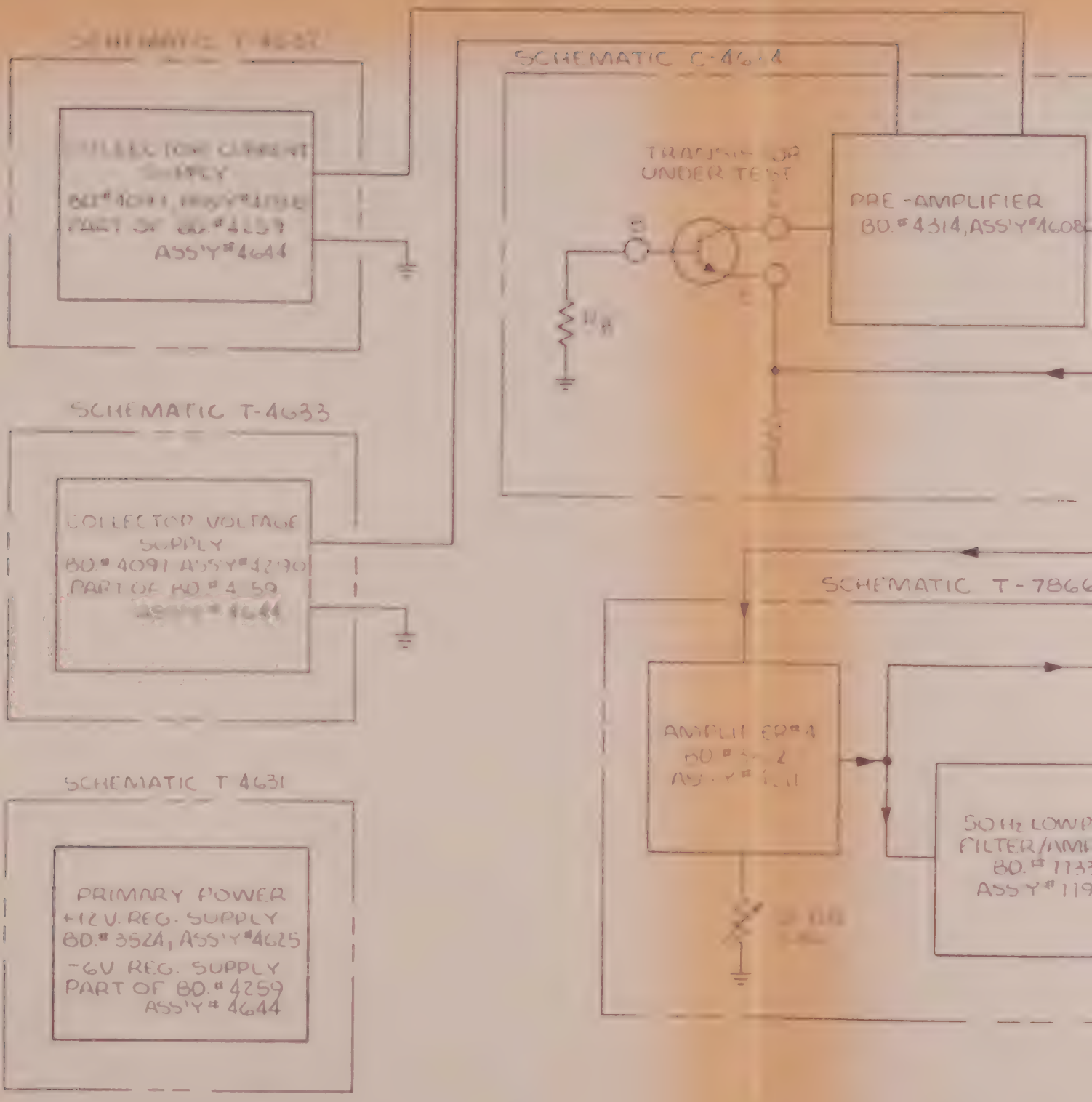
– Front Panel Control

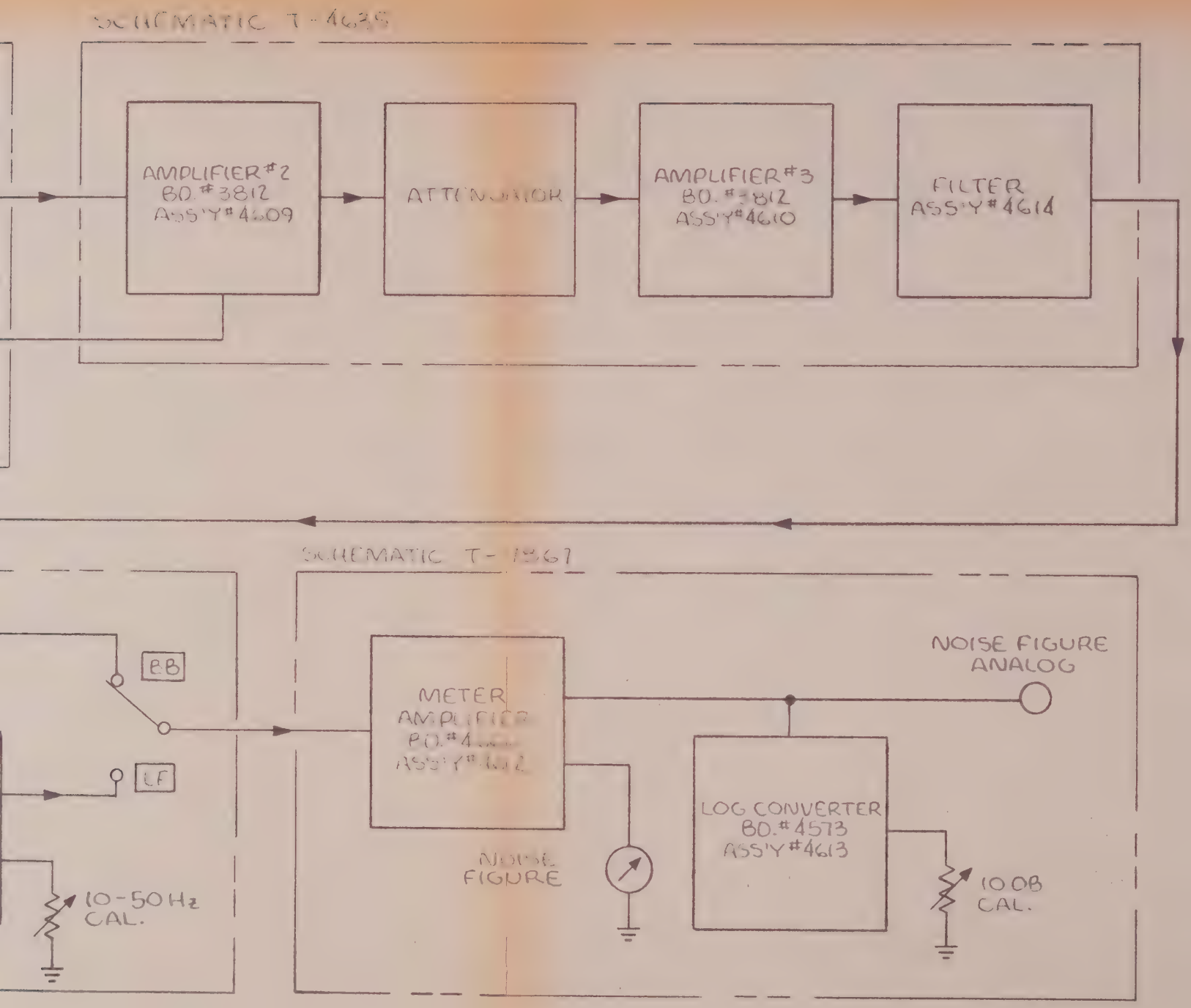
* – Factory Select

Unless Otherwise Specified:

All Resistances in Ohms

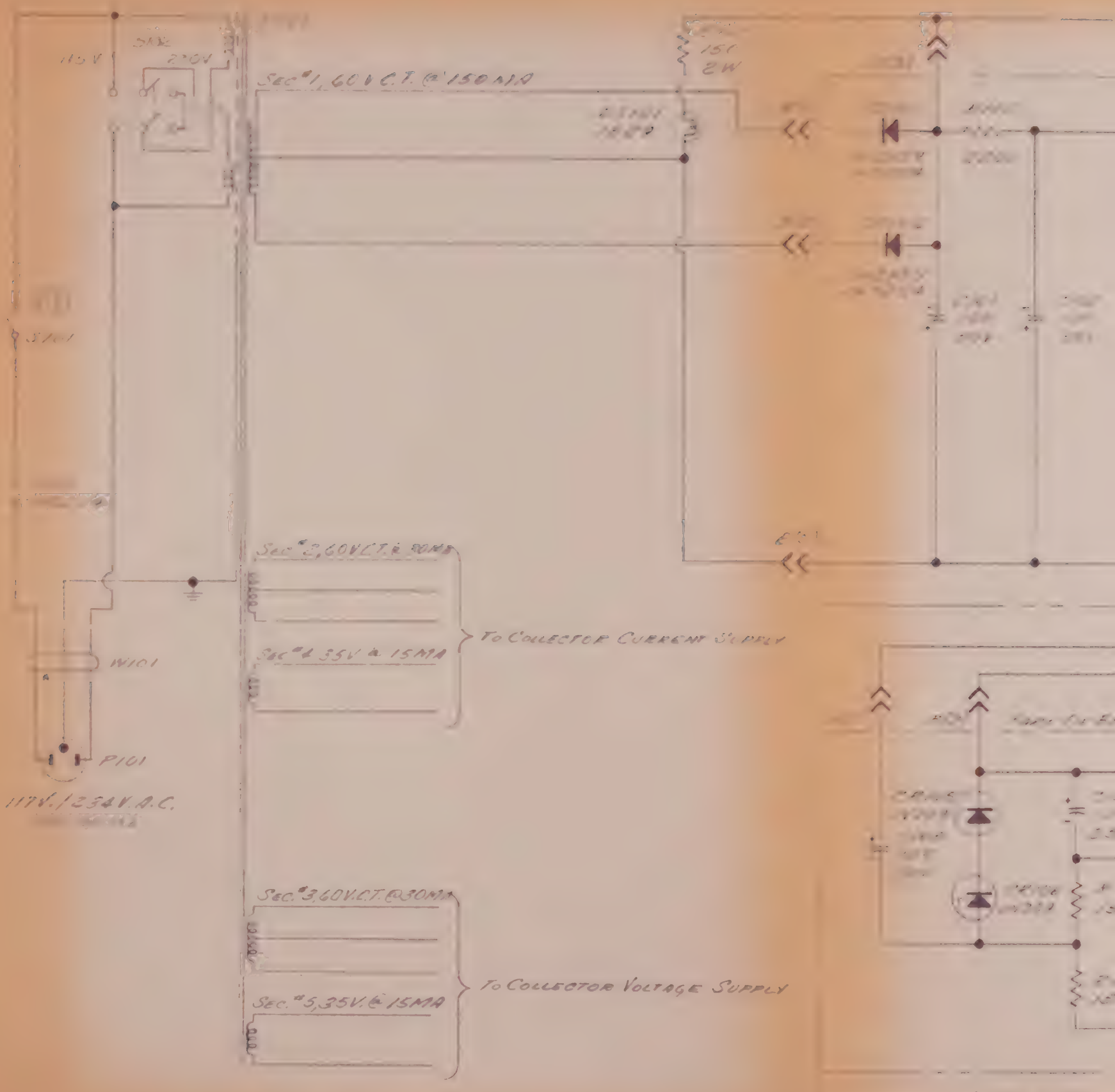
All Capacitances in Microfarads

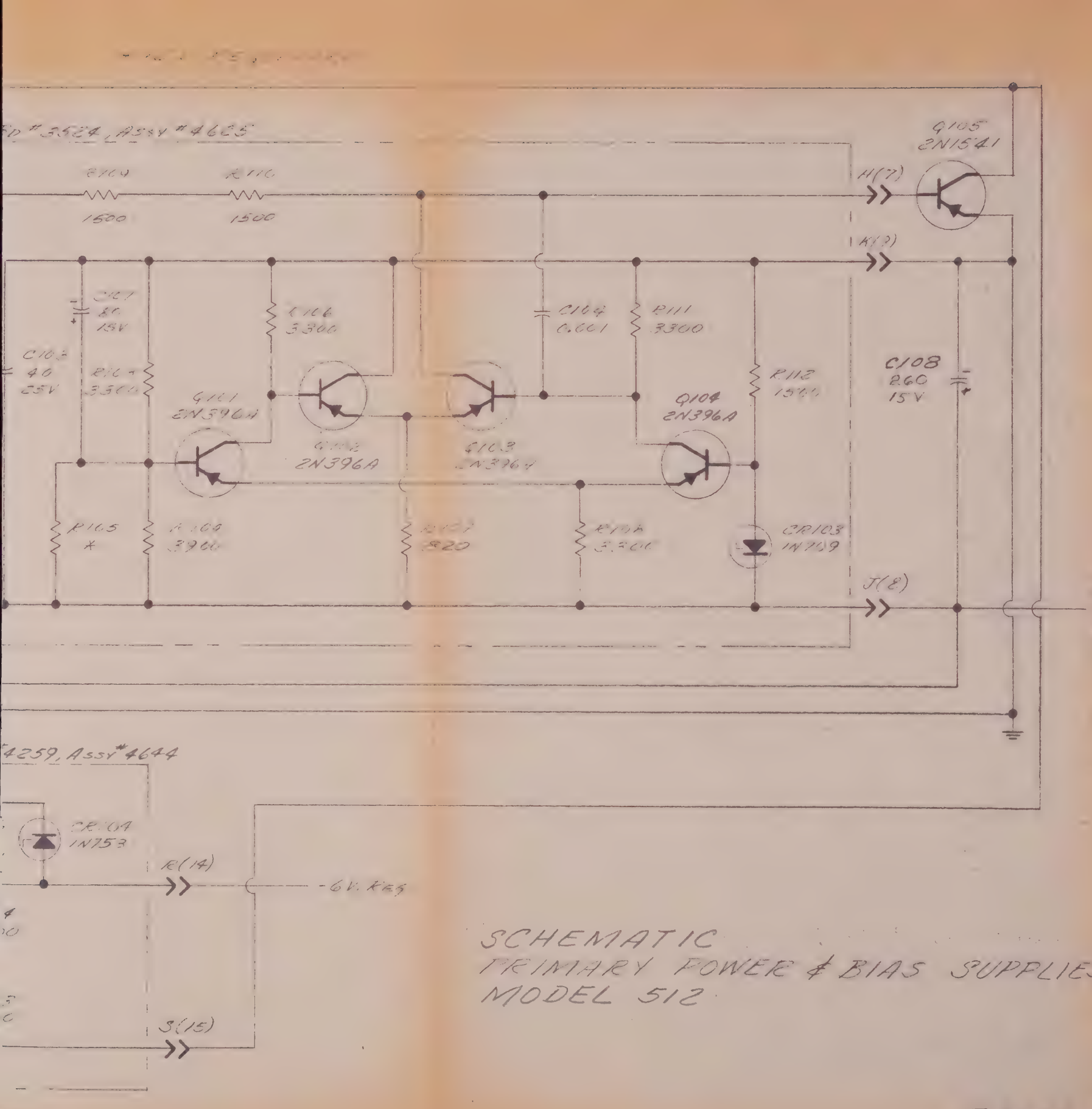

SCHEMATIC T-4632
SCHEMATIC C-4614
TRANSISTOR UNDER TEST
PRE-AMPLIFIER
BD.# 4314, ASS'Y#4608
SCHEMATIC T-4633
COLLECTOR VOLTAGE SUPPLY
BD.# 4091 ASS'Y#4290
PART OF BD.# 4259
ASS'Y# 4644
SCHEMATIC T-7866
AMPLIFIER #1
50 Hz LOWP
FILTER/AMP
SCHEMATIC T 4631
PRIMARY POWER
+12 V. REG. SUPPLY
BD.# 3524, ASS'Y#4625
-6V REG. SUPPLY
PART OF BD.# 4259
ASS'Y # 4644

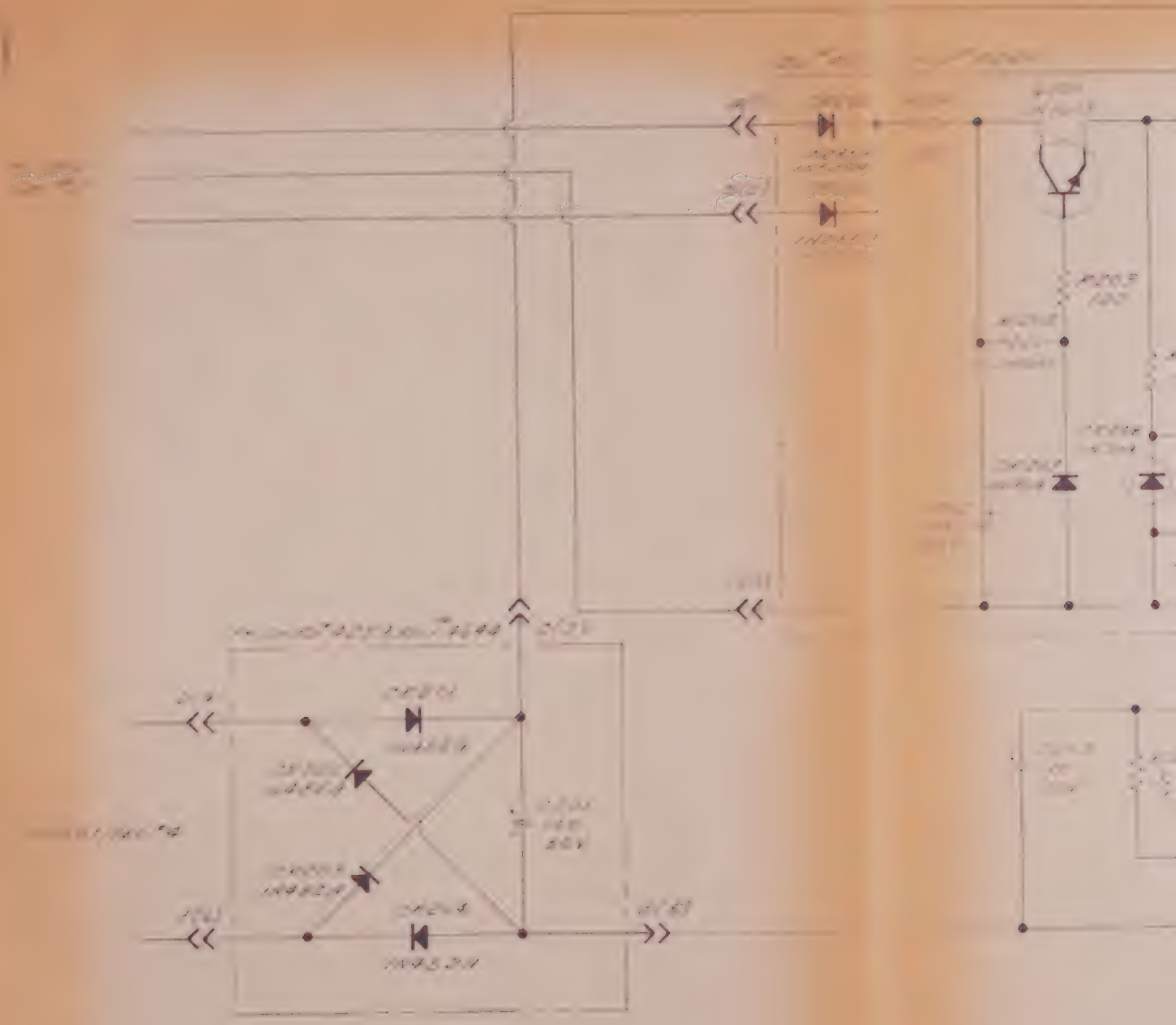


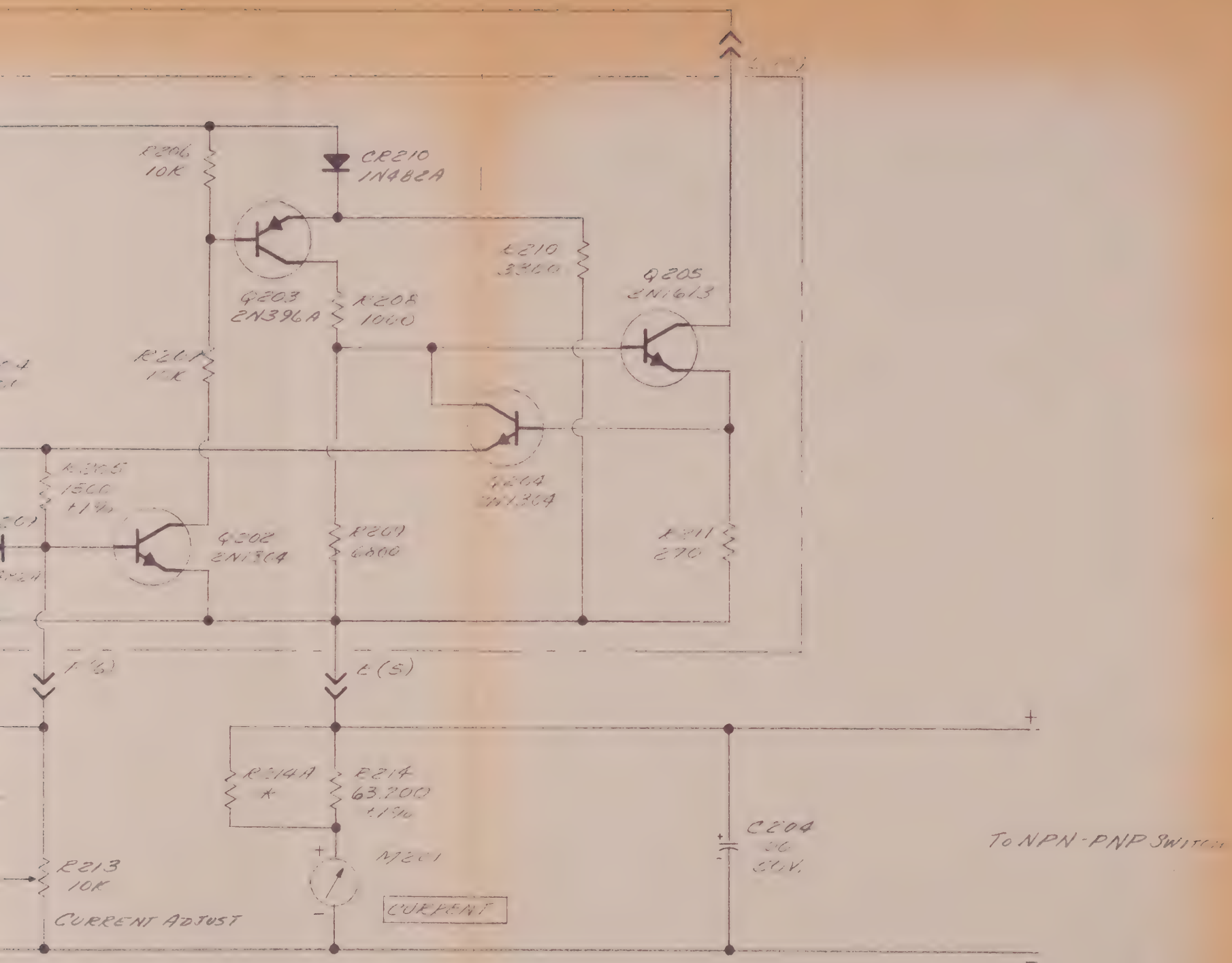
BLOCK DIAGRAM
TRANSISTOR NOISE TEST SET
MODEL 512 B

T-7865 A


115 V
230V
Sec #1, 60 V C.T. @ 150 MA
150 Ω 2W
Sec #2, 60 V C.T. @ 30 MA
Sec #4 35 V @ 15 MA
To Collector Current Supply
W101
P101
117 V. / 234 V. A.C.
Sec #3, 60 V. C.T. @ 30 MA
Sec #5, 35 V. @ 15 MA
To Collector Voltage Supply
-6 V. REGULA

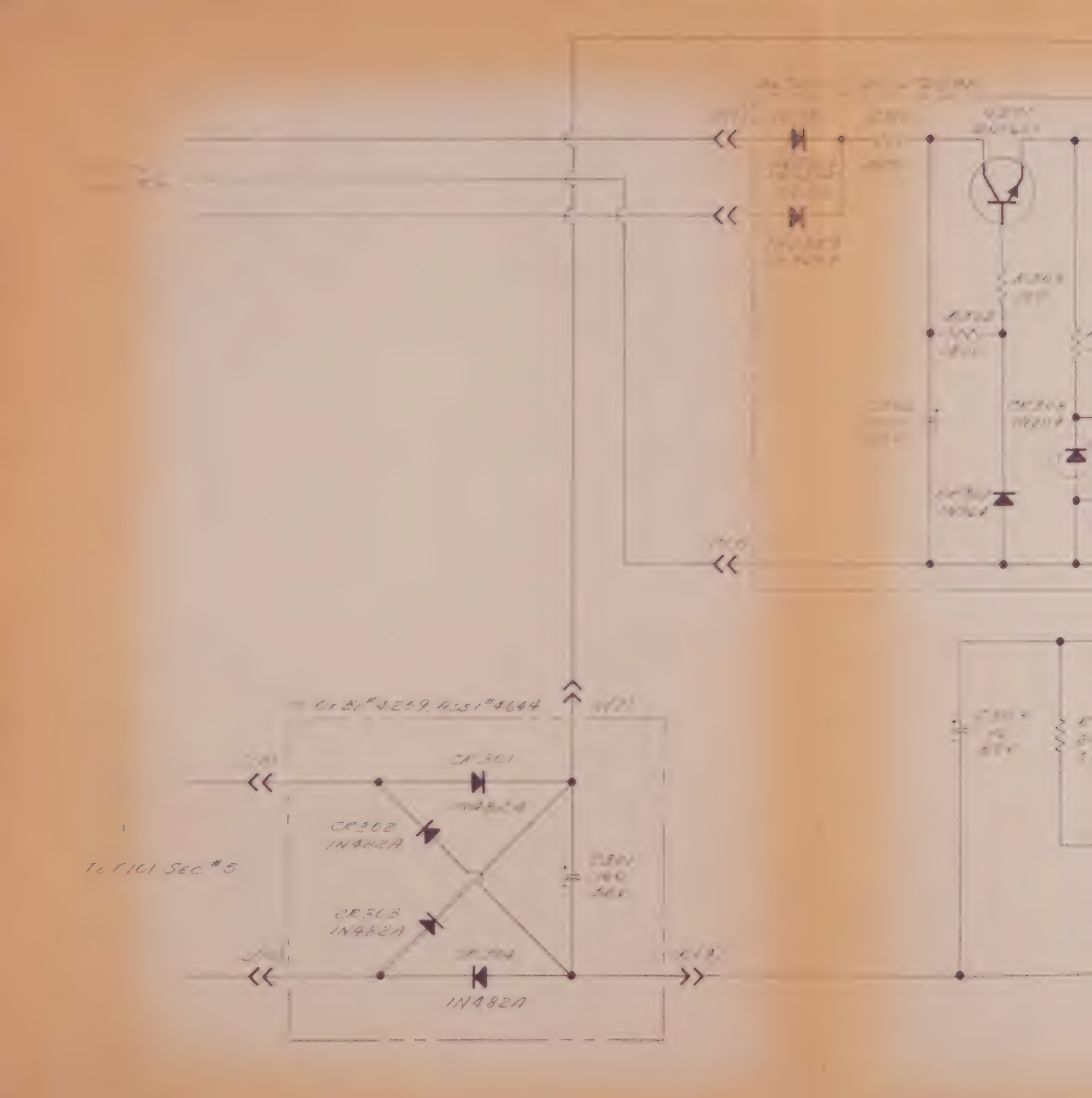

Assy #4625
R104
1500
R110
1500
Q105
2N1541
H(7)
K(2)
C107
40
15V
C106
3300
C109
0.001
R111
3300
C108
260
15V
C103
40
25V
R112
1500
Q101
2N396A
Q102
2N396A
Q103
2N396A
Q104
2N396A
R105
X
R109
3900
R108
820
R106
3,300
CR103
IN709
J(8)
+12V.REG.
Assy #4644
CR104
IN753
R(14)
-6V. REG
S(15)
SCHEMATIC
PRIMARY POWER & BIAS SUPPLIES
MODEL 512
T-4631-S

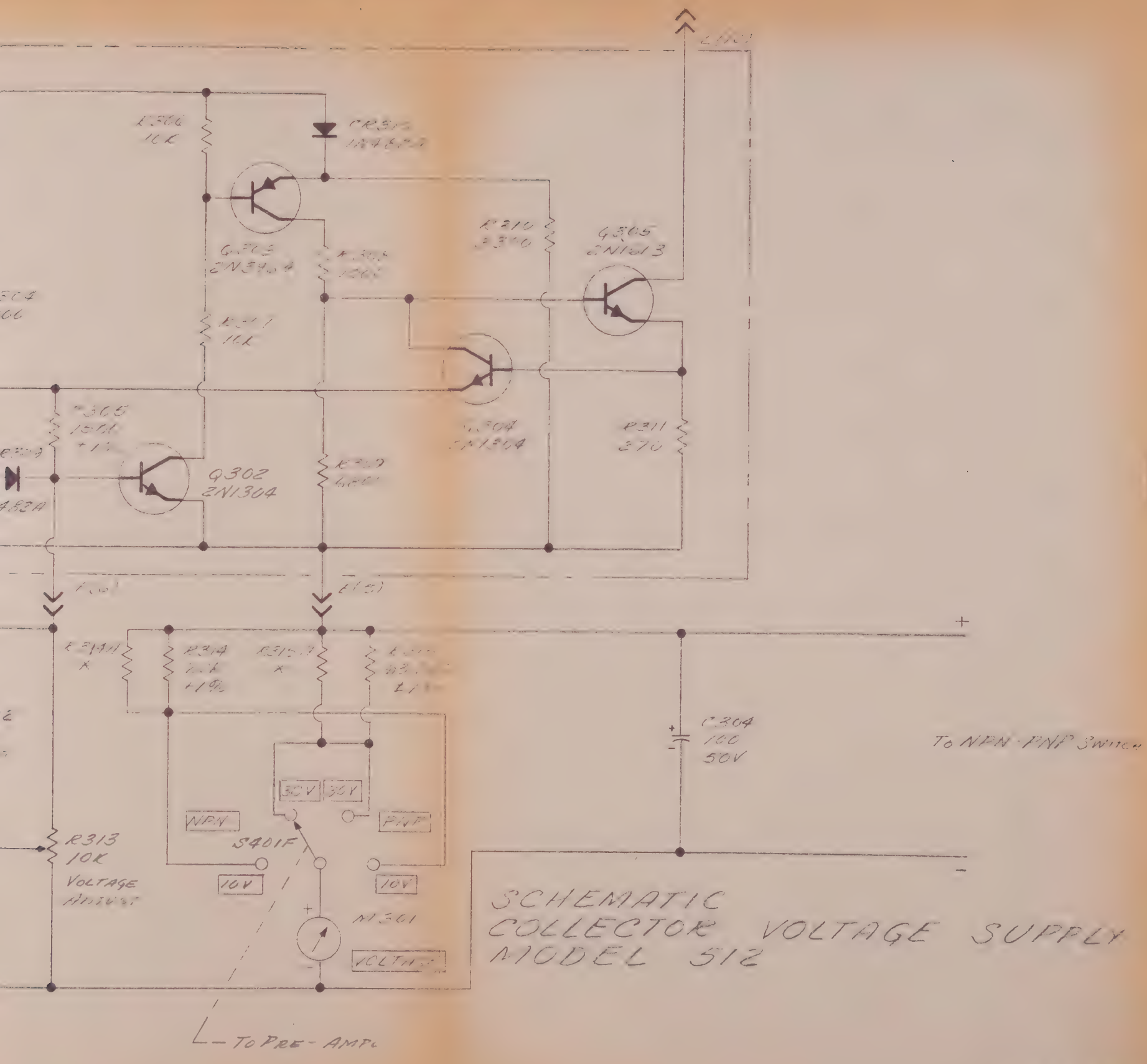




SCHEMATIC
COLLECTOR CURRENT SUPPLY
MODEL 512

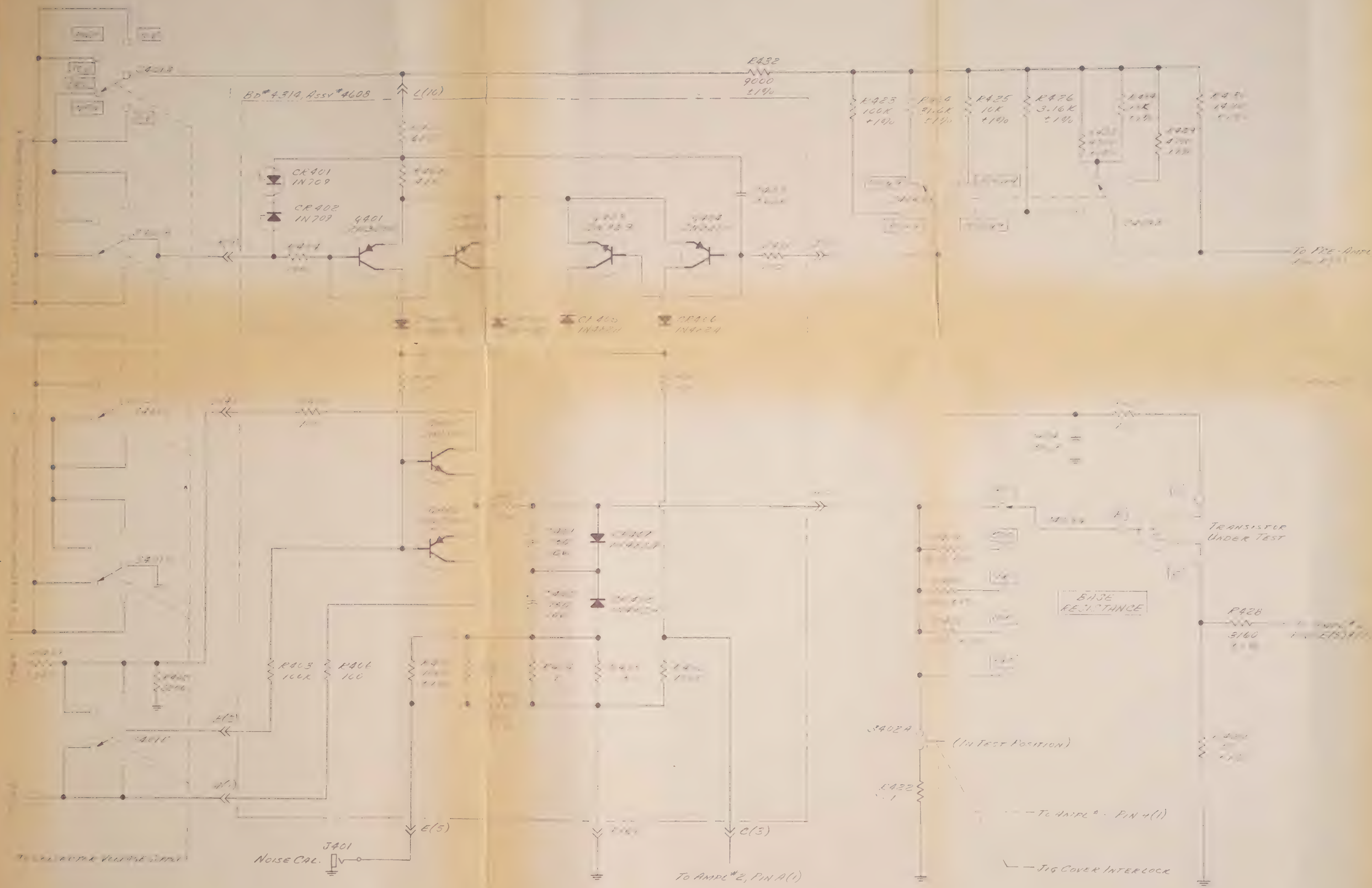
T-46-52-5


CR301
CR302
IN482A
CR303
IN482A
CR304
IN482A
to T101 Sec. #5



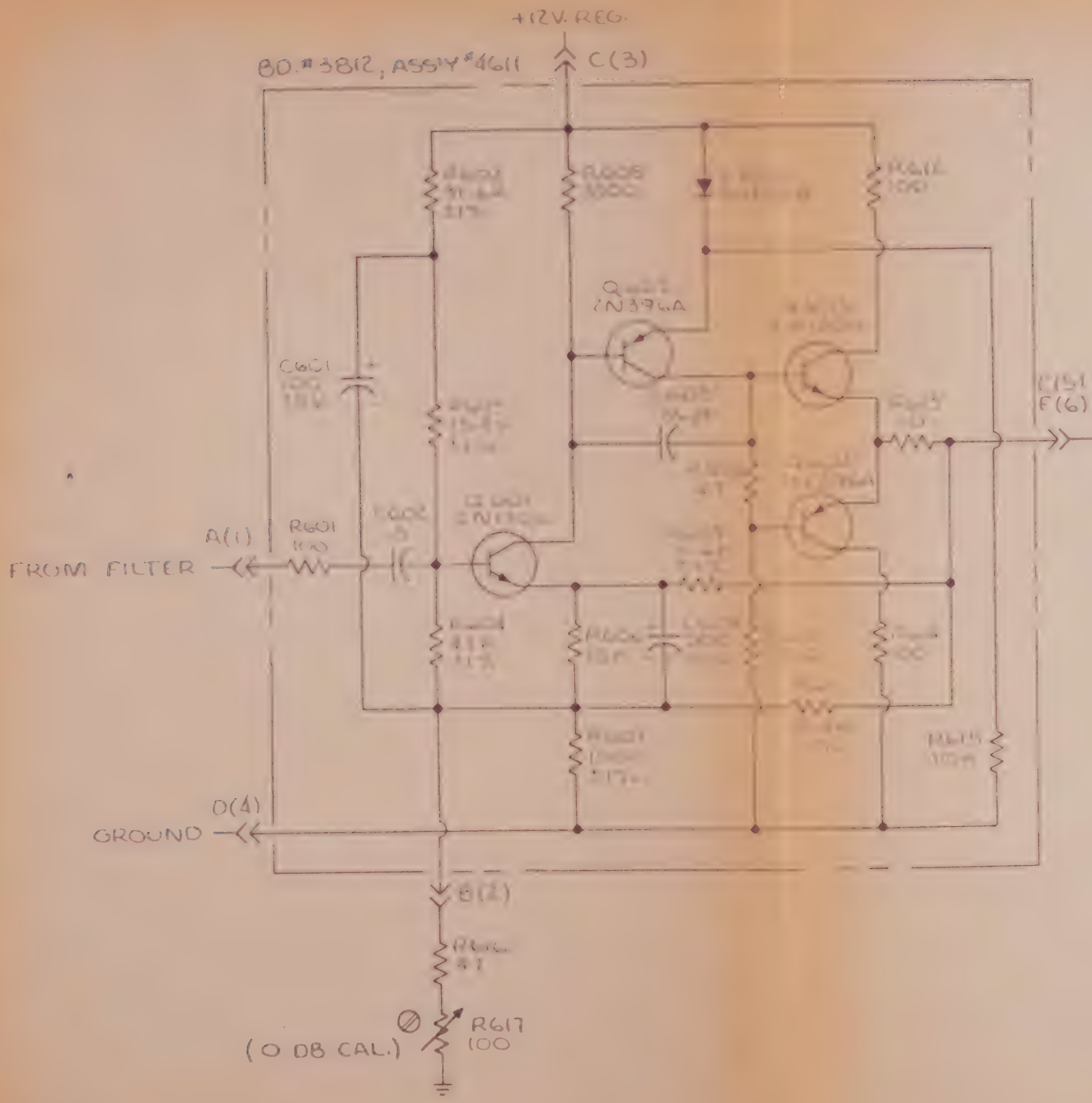
SCHEMATIC
COLLECTOR VOLTAGE SUPPLY
MODEL 512

T-4633-D

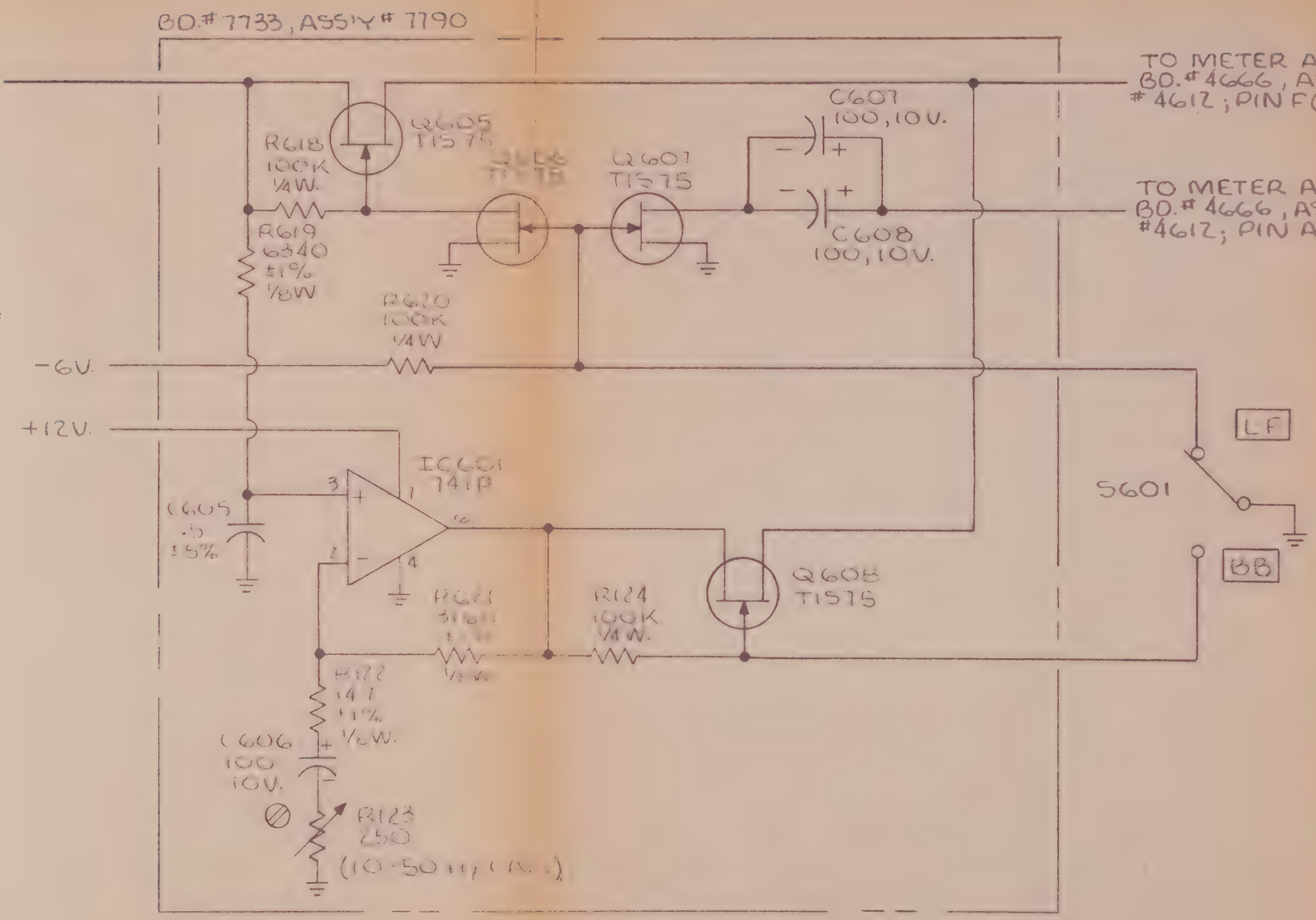


SCHEMATIC
PRE-AMPLIFIER
MODEL 512

C-4634-F


+12V. REG.
BD.# 3812, ASSY # 4611
C(3)
Q601
2N396A
C601
R601
100
A(1)
FROM FILTER
R617
100
(0 DB CAL.)
D(4)
GROUND
B(2)
F(5)
F(6)

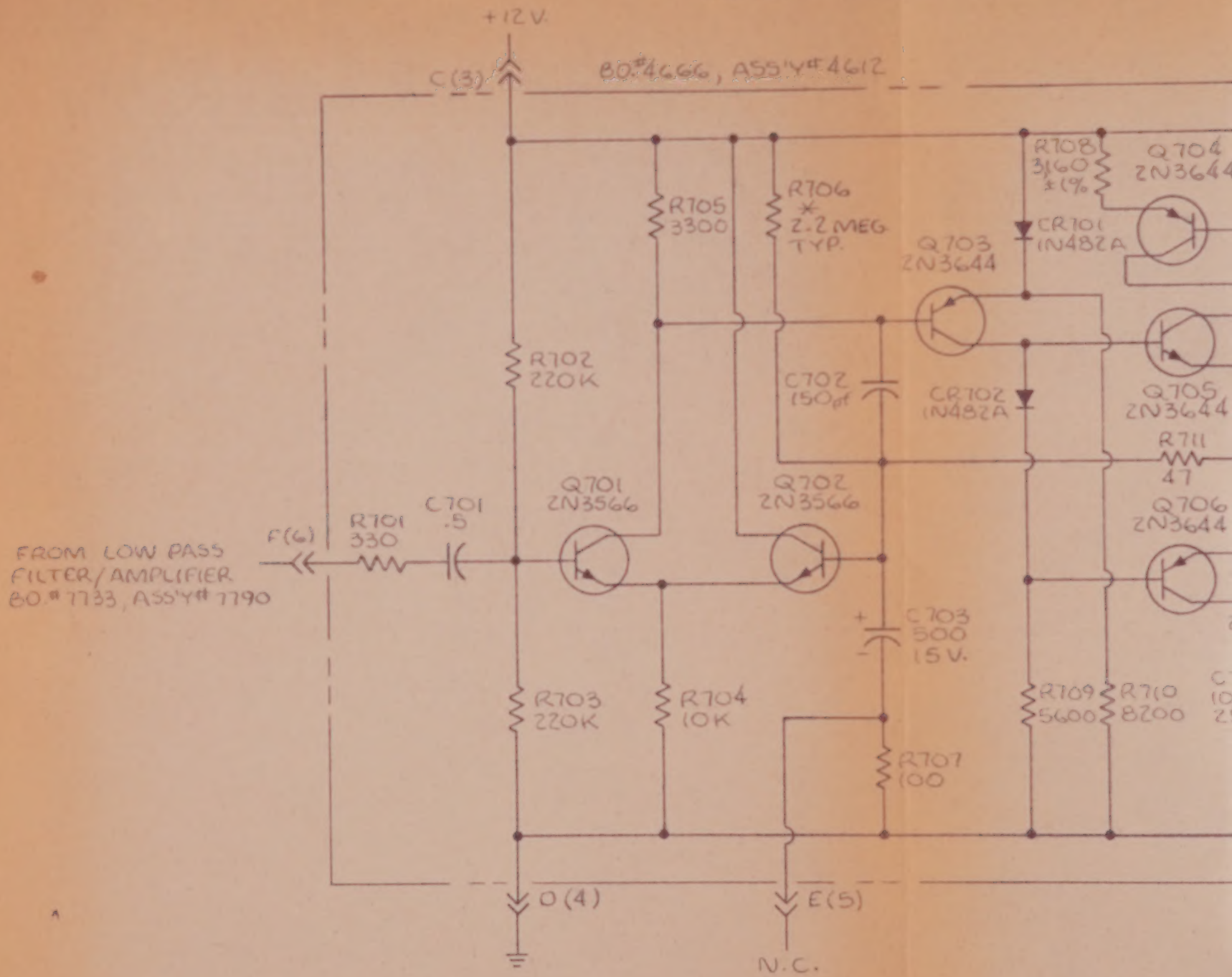
LOW PASS FILTER/AMPLIFIER

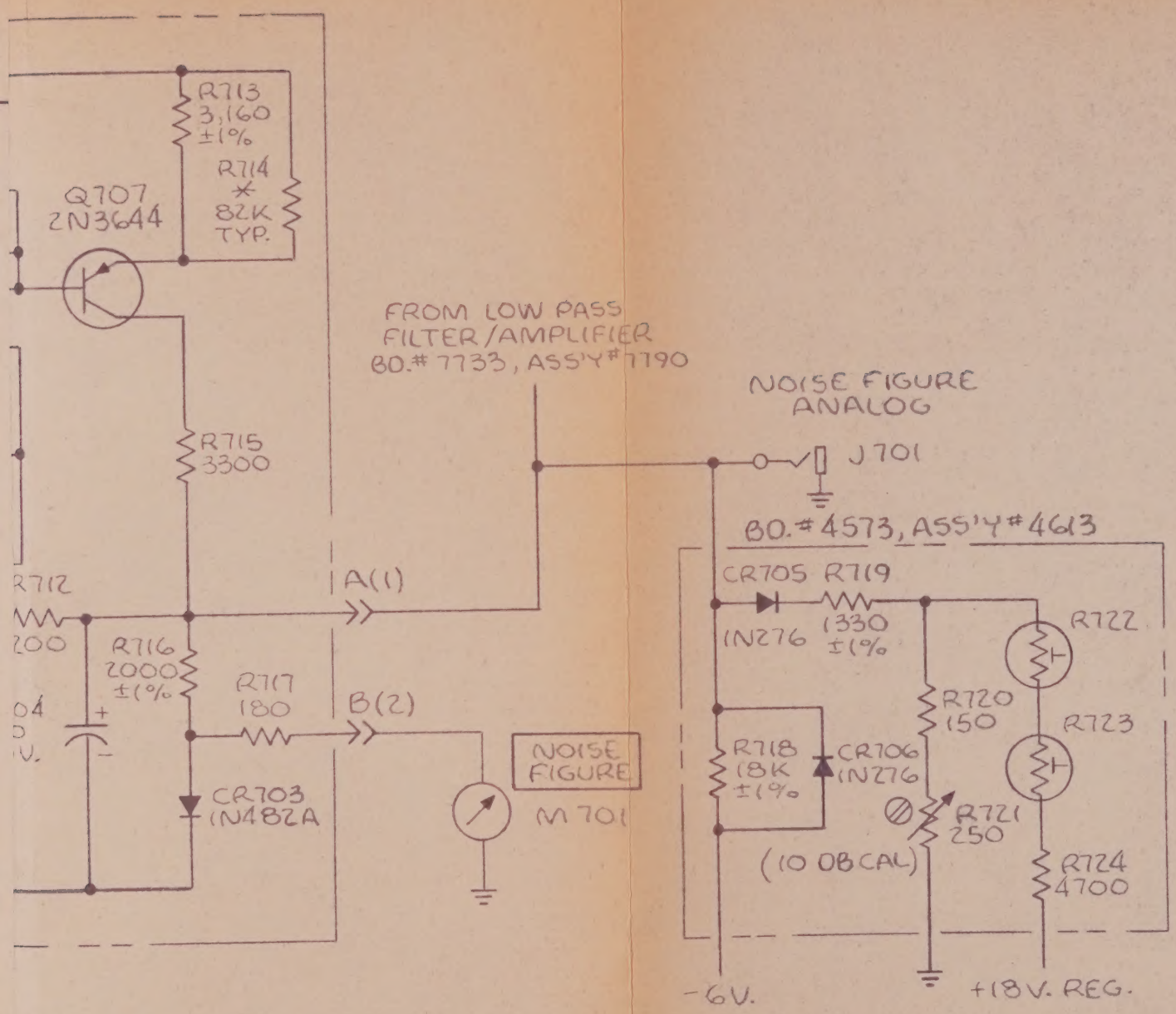


SCHEMATIC
AMPLIFIER # 4 & 50 Hz LOW PASS
FILTER / AMPLIFIER
MODEL 512 B

T-7866 A

METER AMPLIFIER





SCHEMATIC
METER AMPLIFIER &
LOG CONVERTER
MODEL 512B

T-7867

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